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# Utilize 3300-3400 MHz Band for Fixed Wireless Access

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## 1. Introduction

The important role of broadband technologies in Malaysia had been recognized for sufficient spectrum efficiency. Global integration and fast-growing business activity in conjunction with remote multisite operations have increased the need for high-speed information exchange. In many places around the world, the existing infrastructure is not able to cope with such demand for high-speed communications. Wireless systems, with their fast deployment, have proven to be reliable transmission media at very reasonable costs. Fixed broadband wireless access (BWA) is a communication system that provides digital two-way voice, data, Internet, and video services, making use of a point-to-multipoint topology. The BWA low-frequency radio systems addressed in this article are in the 3.5 GHz frequency band. The BWA market targets wireless multimedia services to small offices/home offices (SOHOs), small and medium-sized businesses, and residences.

With the growing importance of the Internet and data communications for business, demand for high-bandwidth data connections has skyrocketed. One of the most viable ways to meet this bandwidth demand, particularly for small and mid-sized businesses and residential areas and especially for the local is through fixed wireless connectivity. Fixed wireless makes it possible for carriers to provide broadband wireless without relying on existing telecommunications infrastructure. It also has a lower cost of entry, with much faster deployment times than wired systems. This is important in servicing the final destinations of telecommunications infrastructures where the cost of service can often be exorbitant. BWA offers users the first opportunity to access a full set of broadband services and application anywhere, anytime and in virtually any way, including on the move.

Licenses for Fixed Wireless Access (FWA) in the 3400 – 3600 MHz band, identified by ITU-R and CEPT/ERC REC, cover operation in a single paired frequency block (Zaid et al., May 2008). Licenses were awarded for geographical regions throughout the tropical countries as a primary served for FSS (Lway et al., Jun 2008). This requires certain procedures to place, in order to assist co-existence and co-ordination. In that band, CEPT/ERC REC14-03 recommends channel arrangements that, for Point-to-Multipoint (PMP) systems, are primarily based on multiple slots of 0.25 MHz with possible duplex spacing of 50 and 100

MHz, but also other rasters (multiple of 1.75 MHz) are provided in the recommendation (Zaid et al., Jun 2008). However, none of the above mentioned recommendations gives any further guidance on the assignment rules among different operators, or different service types, in either co-ordinate or uncoordinated deployment in the band 3300-3400 MHz, leaving to administrations to decide on any further limitations (e.g. in term of EIRP limitation, guard-bands, co-ordination distance, etc.). Also no guidance is given within the referenced documents on how sharing should be managed between PMP FWS that use spectrum adjacent to non-MP services (Zaid et al., May 2008).

Those bands, even if being of limited size, are valuable because they provide for quite wide cell coverage when Line-of-Sight (LOS) rural conventional deployment is considered, as well as connections with partially obstructed (Non-LOS, NLOS) paths and even with simple self-deployable indoor terminals, which is important feature for deployments where simple and cost-effective radio-access connections are desirable. Therefore the bands around 3500 MHz are potentially interesting for a quick growth of domestic/small business access connectivity of moderate capacity, typically for ensuring the policy goals of proliferation of broadband Internet (IP) connections (e.g. in accordance with EU e-Europe action plan).Nowadays different system capacities, modulation formats (e.g. 4 or 16 states using Single Carrier or OFDM) access methods (e.g. TDMA, FDMA, CDMA and OFDM/OFDMA), system architectures (PMP and MP-MP), duplex arrangements (TDD and FDD) and asymmetry (different up-stream/down-stream traffic as typically needed for IP-based access) are exist in the market, but the main focus of this paper is to cover the simplest mixed TDD and FDD systems as a most used technology.

The modulation scheme chosen for the radio system depends on several product definition factors, such as required channel size, upstream and downstream data rates transmit output power, minimum carrier-to-noise ratio (C/N), system availability, and coverage. Higher-modulation schemes provide higher data rates at the expense of better C/N requirements and smaller coverage radii for the same availability, adding to the hardware complexity. For the 64-QAM 7 MHz channel bandwidth signal. A system can require symmetric or asymmetric capacity depending on its specific application. For a symmetric capacity system, upstream and downstream traffic are equivalent, whereas for an asymmetric system the downstream link usually requires more capacity. Hence, higher-level modulations with higher capacity are better suited to downstream transmissions. Using n-QAM modulations for downstream transmission becomes advantageous, whereas QPSK can be used in the upstream direction. Since lower-level modulations perform better in more constrained environments, they can be not only used in burst, low-power, low-capacity, or upstream transmissions, but also adjusted dynamically in link fading conditions.

We have to mention that each technology offers to operators specific benefits for specific market segments/characteristics; some of these technologies would enlarge the field of possible applications, for instance to nomadic applications for indoor terminals (Zaid et al., Jun 2008). We will take the same region – block edge mask, typical ETSI mask positioning, flow diagram for the co-ordination process as a considered parameters.

The remainder of this chapter is organized as follows. In section 2, the current problem of interference and interference scenarios had been discussed in conciseness. Section 3 is devoted to describing the system parameters. Section 4 discussed the adjacent band division. In section 5 we concluded the mask idea and we elaborated in the case study in section 6. Finally, conclusions are presented in Section 7.

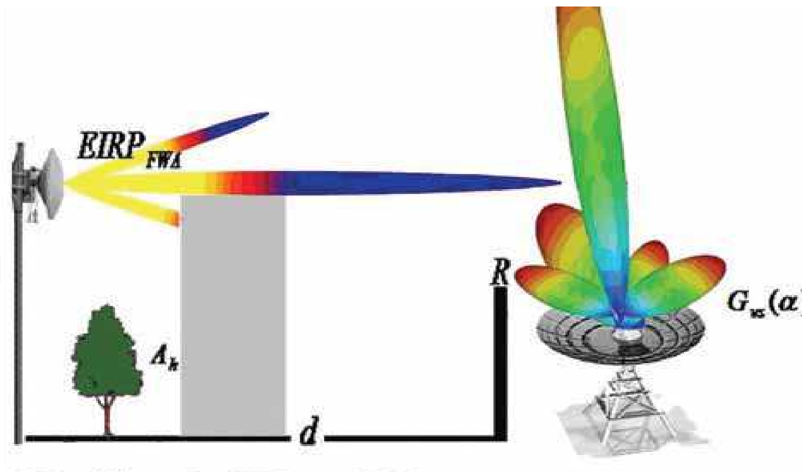
## 2. Current Problem

The spectrum is limited natural resource, essential to global, regional, domestic communication infrastructures for the radio-frequency (RF) services and once we used portion of a spectrum for one service an RF planning should be considered to improve the functionality of that service without interference on other services. Fixed Satellite Services (FSS) relaying on C-band used in many countries around the world. However, sharing studies between FSS and terrestrial systems had been started in 2003. Nowadays FSS had been potentially used for essential Communication services especially in tropical regions, mission-critical communications solutions like distance learning, Universal access, tele-medicine, telemetry and command, DTH (direct to home), disaster recovery, and many other vital applications.

The signal received by FSS receiver is very week due to distance (about 36000 Km geostationary satellite orbit (GOS)). Therefore, when FWA will use C-band frequency it will block the FSS reception and problems of Co-channel, adjacent channel interference and LNB behavior will pup up. On the other hand, for the FWA systems there is an urgent Importance of new method to prevent the interference with more accuracy, to reduce the isolation. Challenges represents in create a new method of Guard band which enhance the Idea of preventing the interference, and support the coexistences (Lway & Tharek, May 2008). However, depending on the C-Band for some countries is vital issue because of the rain attenuation effect for the high frequencies. On the other the Fixed Wireless Access had been deployed to work on a part of C-band from 3400-3600MHz, as clarified in Malaysian spectrum plane Figure 1.


Fig. 1. Malaysian spectrum plane for 3400-4200MHz.

Some countries gave the priority of using C-band to the FSS services, and regulation made to keep a separation distance between both services according to the ITU-R studies, beside the clutter loss consideration we may not be able to deploy both FSS and FWA services in the same area because of the interference (Lway & Tharek, May 2008), as elaborated in figure 2.




$$20Log(d) = -I + EIRP_{FWA} - 92.5 - 20Log(F) - A_k + G_{vs}(\alpha) - R$$

Fig. 2. Separation distance formula within the clutter loss effect when Ak is a factor related to the territories, D is distance, R is the shielding loss, EIRP: is the radiated power from the FWA transmitter, F is the frequency and Gvs is related to the typical receiving FSS antenna gain.

This separation distance will be come a very huge distance which is impossible we rely on because of the high sensitivity of FSS receiver, since the FSS signal is very week for the Geostationary satellite station which is 36000 kilometers faraway from the earth, figure below (Figure 3) shows the maximum acceptable in-band interference between the two services.

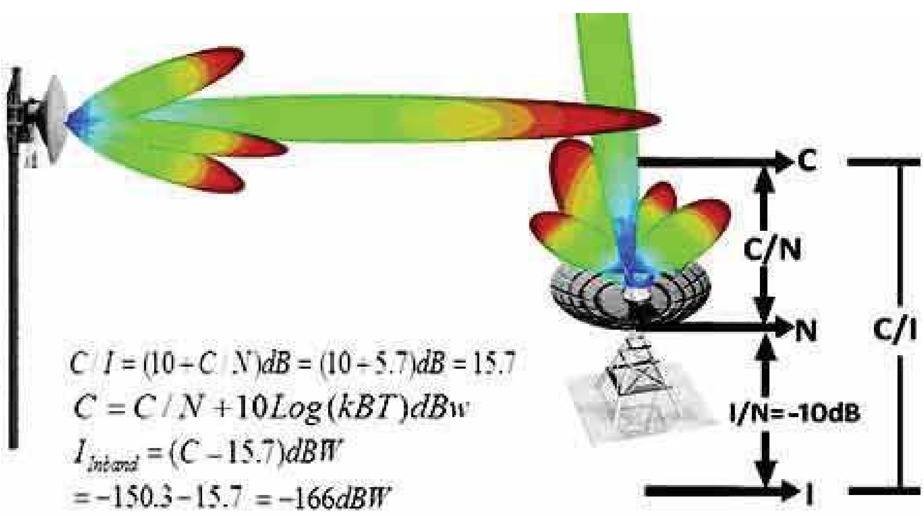



Fig. 3. Maximum acceptable in-band interference between FSS and FWA, when I: is the interference level, C is the carrier signal, N is the receiver noise level.

A technique for enabling the coexistence of both systems would be to introduce a large geographical offset between two systems if we didn't deem the guard band and improve adjacent channel leakage ratio (ACLR) and adjacent channel system (ACS) of equipment (Lway & Tharek, May 2008). Co-located and non co-located base stations will require additional filtering and site engineering to facilitate coexistence between the two systems (Lway & Tharek, May 2008).

## 3. Specifications

### 3.1 FSS Specifications

For Malaysia as a case study the fixed satellite service is allowed to work within 3400 to 4200MHz, and the receiver frequency bandwidth is varying from 4 KHz to 72MHz, base on different use. Following table 1 describing the typical FSS earth station already in use by Petronas station (fuel stations).

| Specifications | Satellite terminal |
|---|---|
| Antenna diameter (m) | 2.4 |
| Gain (dBi) | 38 |
| Antenna diagram | ITU RS.465 |
| Noise temperature | 114.8oK |
| Elevation angle | 75.95 |
| Azimuth | 263.7 |
| I/N | -10dB |
| I | -166dB |
| Fc | 3436MHz |
| Receiver bandwidth (MHz) | 72 |

Table 1. Fixed satellite services specifications

### 3.2 Fixed Wireless Access Specifications

In Malaysia the frequency range (3.4-3.6) GHz is allocated for FWA systems, It is divided into sub-bands for duplex use (non duplex systems can still be used in this band), 3400–3500 MHz paired with 3500–3600 MHz. However, Countries have various frequency channel spacing within the 3.5 GHz bands 1.25, 1.75, 3.5, 7, 8.75, 10, 14, and 28 MHz can be used according to capacity needs. Currently, this services had been stopped because of there impact on the FSS receivers. Alternatively, if we change the parameters defiantly we will gate a grate change in the interference upshot. So, we will be focused on the parameters listed in Table 2 and we had considered that the FWA working band is 3300-3400MHz (Zaid et al., May 2008).

| Specification | FWA(TS) |
|---|---|
| Tx Peak output power (dBm) | 36 |
| Channel bandwidth (MHz) | 3.5 |
| Peak BS antenna gain (dBi) | 15 |
| Antenna gain pattern | ITU-R F.1336 |
| Base station antenna height (m) | 30 |
| Noise figure (dB) | 7 |
| Interference Limit Power (dBm) | -109 |

Table 2. Fixed wireless access specifications

## 4. Finding the Adjacent Band

To use the FWAP2MP in the band (3300-3400), interference will appear according to the out of band emission of FWA which will have the impact on the FSS receiver. This study has covered the minimum possibility of interference by proposing 3.5MHz bandwidth for each sector in the FWA Base station, so the band described in figure 4.

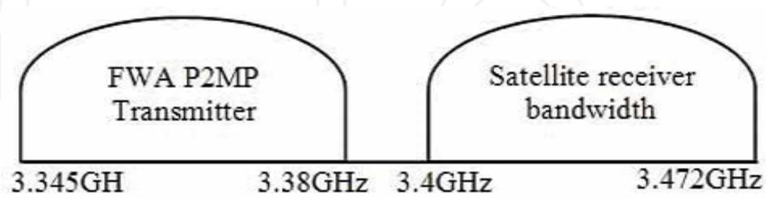



Fig. 4. Proposed scenario

This scenario is covered the possibilities of deployment two FWA operators in the band 3.3-3.4 and the impact on the FSS receiver, the FSS receiver bandwidth is exactly in the adjacent channel within 72MHz band width. 20MHz as Guard band between two services (FSS and FWA), as clarified in figure 5.
For the examples of P2MP FWA applications, it appears that most of them are designed for a cell coverage methodology of "reuse four", using four frequency channels with separation of typically 3.5 MHz. The channel size of system is in practice constant at 14 MHz (3.5X4), the recommended assignment methodology provides for blocks composed by 14 MHz channels, keeping, for mixed TDD and FDD licensing, one further channel as guard band (total is 17.5MHz). Therefore, for contiguously adjacent, technology neutral blocks that may need to contain also suitable guard bands inside those blocks, this would require block sizes that would exceed the 4 x ChS by an amount of one additional channel. Therefore in such cases of contiguously assigned blocks, typically required block sizes might be in the order of: System channel raster 3.5 MHz: Block size B=~17.5MHz. But, if an external guard bands are employed between the assigned blocks, then the suitable size of assigned blocks should be equivalent just to the sum of 2 reference channel bandwidths.

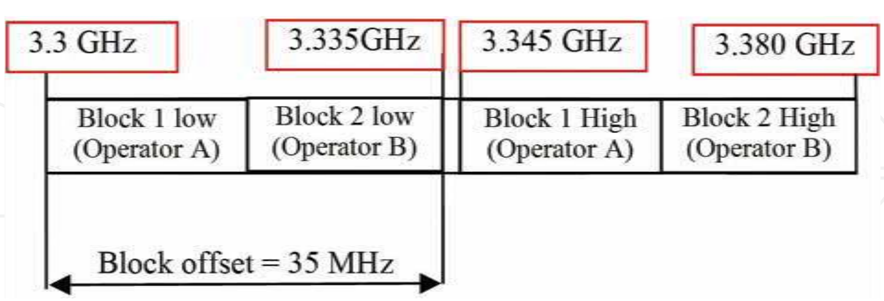



Fig. 5. Guard band between two operators

## 5. FWA Mask

The figure 6 below explained how much Guard and we need to reduce the interference to Zero, However the signal received from of FSS receiver shouldn't exceed the interference level -166 dB (Lway et al., Jun 2008).

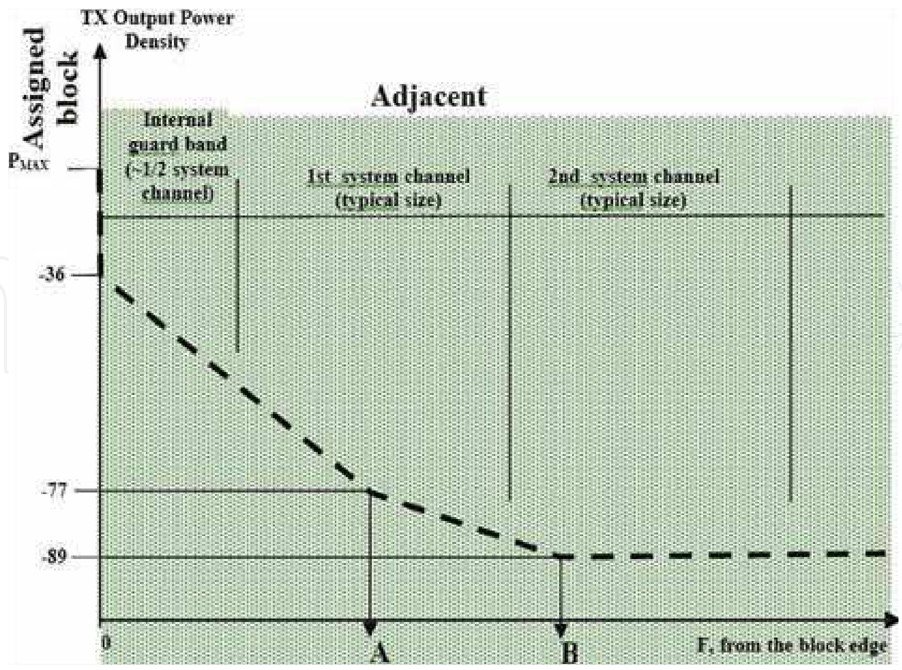



Fig. 6. suppression mask of 3.5MHz bandwidth for FWA

We can conclude the result of the mask simulation into a table as described in Table 3.

| Frequency offset break points for the mask | Definition (% of the size of the assigned block) |
|---|---|
| A (-77dB) | 20% |
| B (-89dB) | 35% |
| C (-123dB) | 75% |
| D (-166dB) | 113% |

Table 3. Frequency mask boundaries

Theoretically, Since 1.75 of the system channel typical size equal to 35% of the size of the assigned block. So, 113% of the size of the assigned block equal to 5.65 of the system channel typical size.
Thus; Minimum Guard band required is: 5.65 x 3.5=19.775MHz

## 6. Case Study: Block Edge Spectral Density Mask of FWA ETSI- EN301021

The spectrum emission mask is a graphical representation of a set of rules that apply to the spectral emissions of radio transmitters. Such rules are set forward by regulatory bodies such as FCC and ETSI. It is defined as the spectral power density mask, within $\pm$ 250 % of the relevant channel separation (ChS), which is not exceeded under any combination of service types and any loading (Lway & Tharek, March 2008). The masks vary with the type of radio equipment, their frequency band of operation and the channel spacing for which they are to be authorized. The transmit spectrum mask is considered in this study because it may be used to generate a "worst case" power spectral density for worst case interference analysis purposes, where the coexistence study can be applied by spectrum emission mask as an essential parameter for adjacent frequency sharing analysis to evaluate the attenuation of interference signal power in the band of the victim receiver. Figure 7 is a generated spectrum mask in Matlab. (zaid et al., May 2008)

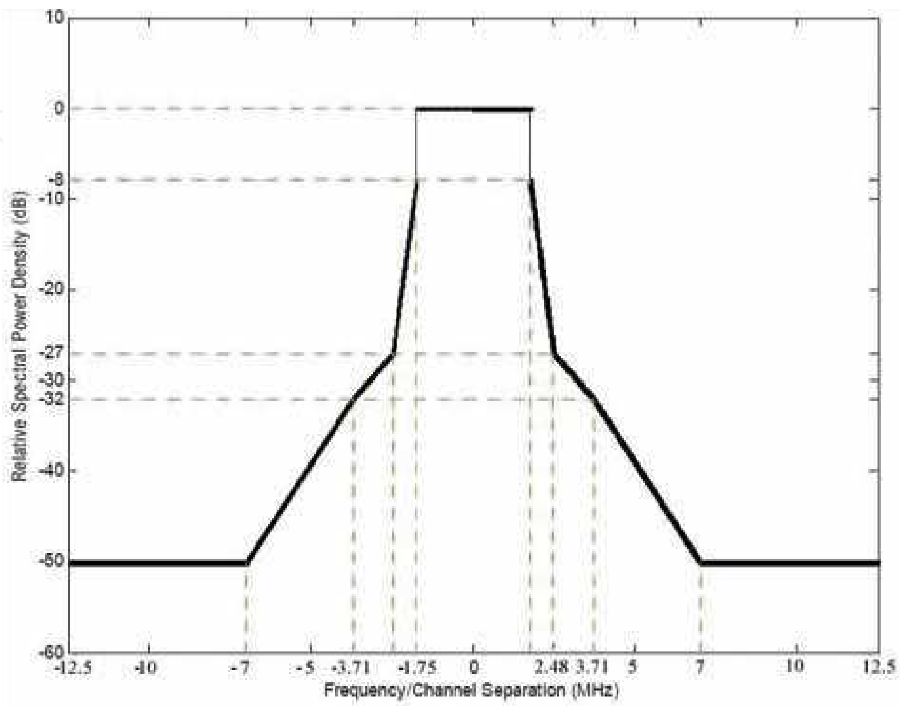



Fig. 7. Generated spectrum mask

From FWA base station (BS) systems into FSS receiver as a victim, if we don't want to consider the separation distance with minimum I/N ratio of -6 dB are analyzed according to the selected bandwidth of FWA channels in the dense urban area (clutter loss (Ah)=18.5).
It can be observed that within 20 MHz as a Guard band the minimum separation distance between the two base stations is 20m as in figure 8.

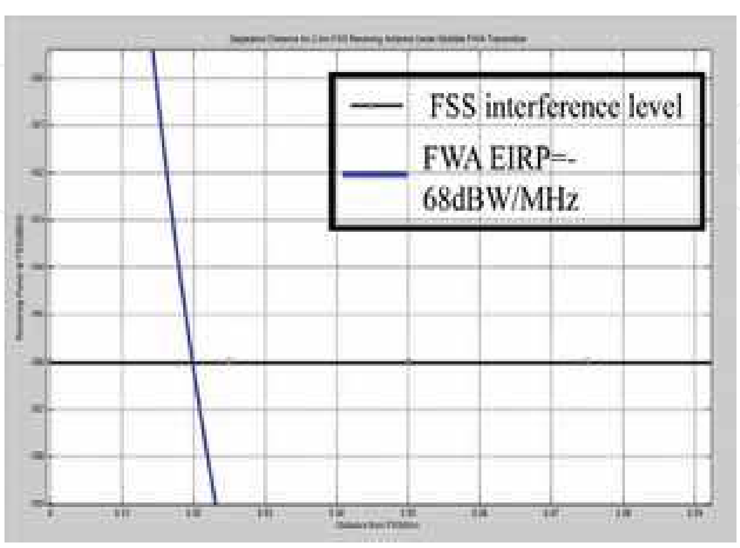



Fig. 8. Separation distance from FSS to improve the coexistence.

## 7. Conclusion

Different brands of FWA can have different Mask shape, radiated power and deferent assumption; generally 20MHz Guard band is quite good for the proposed scenario. If we want to use more bandwidth for the FWA like 7MHz we will be able to deploy only one operator and 10MHz bandwidth is not applicable. Theoretical justification is required before practical implementation. However, link budget, MultiPoint site deployment details and FWA versus FSS adjacent region (or country), same frequency block, will be considered in the future work.

The rural telecommunication network must be configured according to the user's requirements. Foremost in this, the network must always be available and capable of providing voice service in meeting the user's expectation. The Fixed Wireless Access technology gives more advantages and has higher reliability than any other wire line or wireless technologies. Its capability in providing coverage over the large coverage areas and relatively immune to topography makes this technology become more attractive for improving the telecommunication system in the rural areas.

Alternative uplinke and downlink frequency operation for FWA systems considered in term of frequency allocation and implementation.

Unlike the fast developing technology such as mobile communication or wireless, the development of rural areas will be the future work of this study, as it generates much revenue for telecommunication companies. Thus, there is a need for more research to be conducted on rural information computer technology employing advanced technology which can be implemented at low cost.

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